

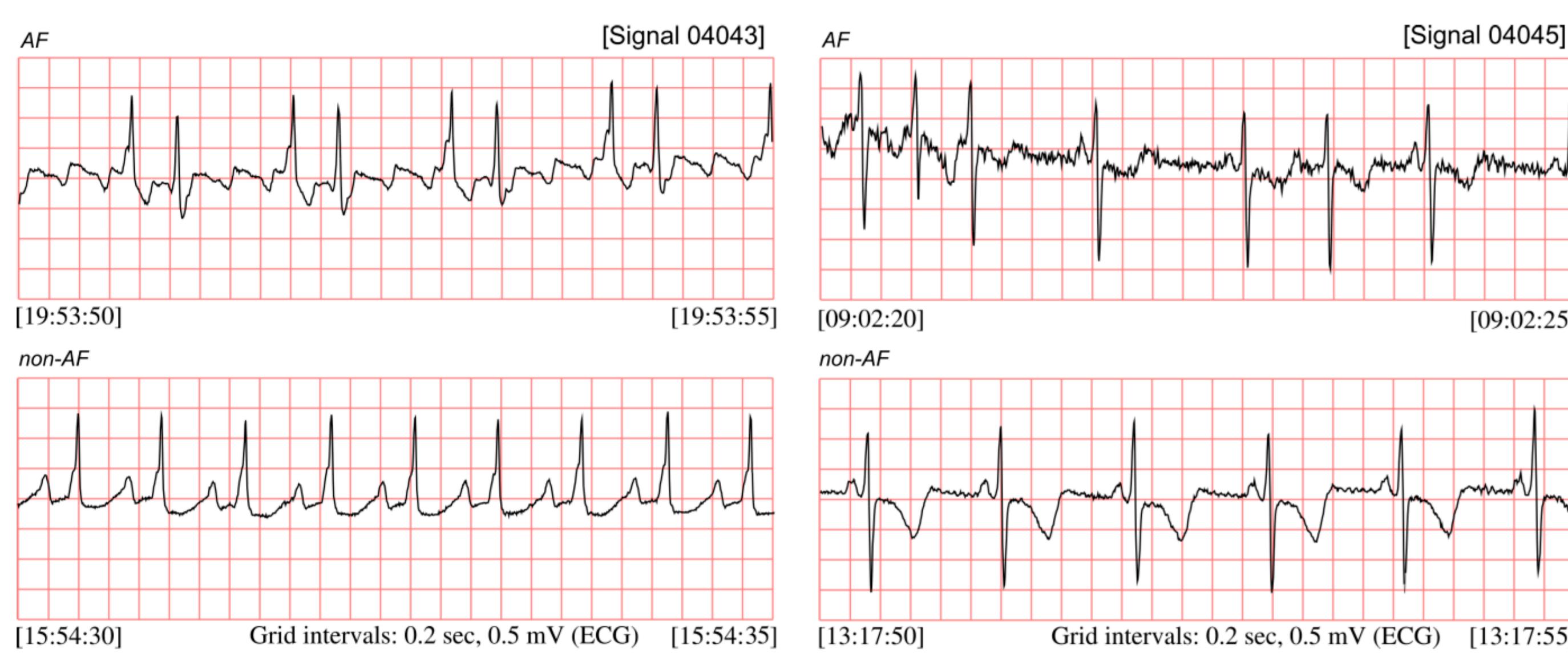
# Characterizing Atrial Fibrillation during and after Cardiac Surgery: An Exceptional Model Mining Approach on ECG Morphology Abnormalities

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## Consequences of Atrial Fibrillation

Atrial Fibrillation (AF) is a **cardiac arrhythmia** occurring in 20%-50% of the patients who undergo cardiac surgery. Patients experience increased and irregular heart rhythm, which can lead to turbulent blood flow and in turn **blood clots or even strokes**. Early prevention for risk groups can be critical. Nevertheless, current applications of data mining are **black boxes**. Medical workers should know how algorithms' decisions are made to increase trust and help explain decisions to their patients.

We propose a transparent characterization of AF.

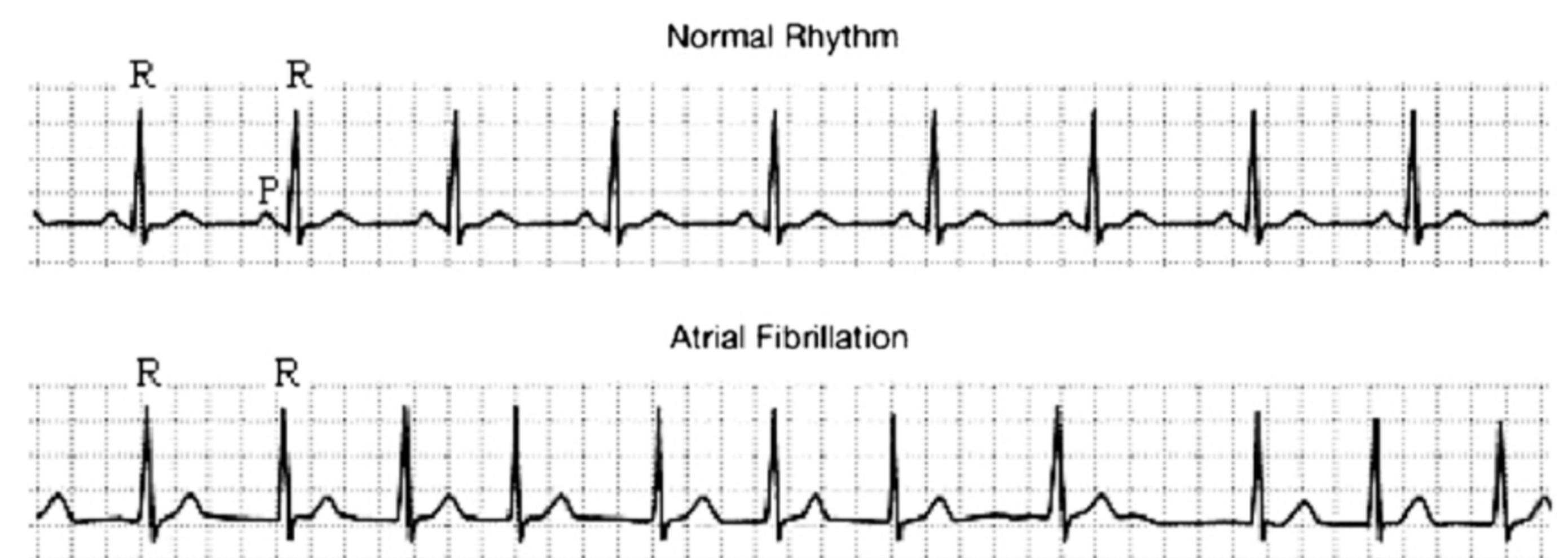


## Exceptional Atrial Fibrillation Mining

Exceptional Model Mining (EMM) finds explainable and actionable risk groups by identifying subgroups with exceptional AF based on the characteristics in the ECG signal: **irregular heart rate** and **missing P-waves**.

$$\varphi(D) = \varphi_{\text{ef}}(D) \cdot (\bar{\theta}_G - \bar{\theta}_H)$$

$$\theta_{SDSD}(r) = \sqrt{\frac{1}{K-3} \sum_{i=1}^{K-2} (\Delta RR_i - \bar{\Delta RR})^2} \quad \theta_P(r) = \frac{1}{K} \sum_{i=1}^K P_i$$



### HRV-based: SDSD

#	n	Description
11	3	Gender = Female, Base Excess = (-2.9; 0.0) (normal), and CTC0000210 = False
12	3	Calcium Gluconate = (16.7; 170.0), and Creatine Kinase in (763.0; 841.0) ( <b>very high</b> )
13	4	Gender = Female, and Base Excess = (-2.9; 0.0) (normal)
14	3	Macrogol at home = True
15	3	pH in (7.38; 7.42) (normal), and Fibrinogen = (1.6; 2.2) (low)

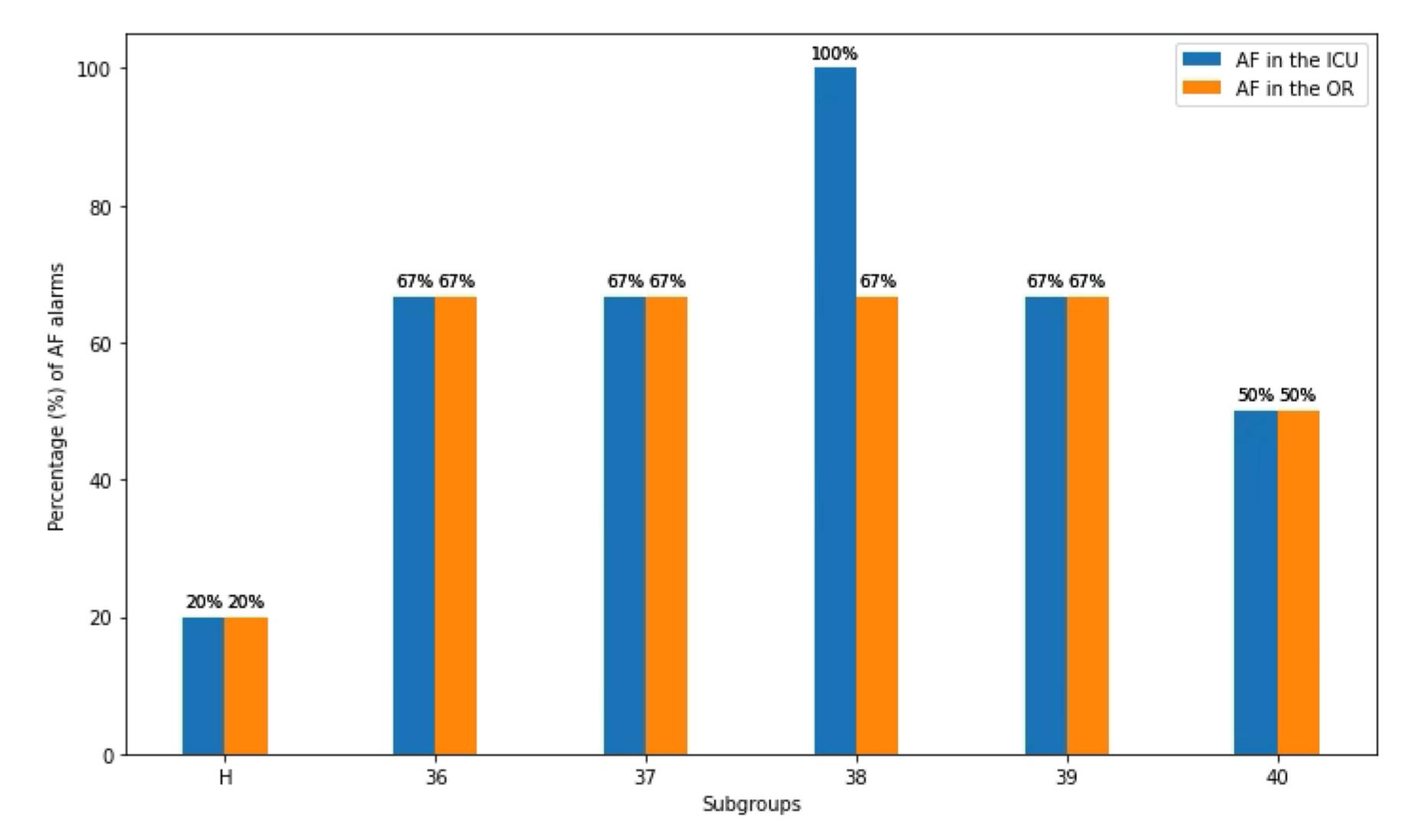
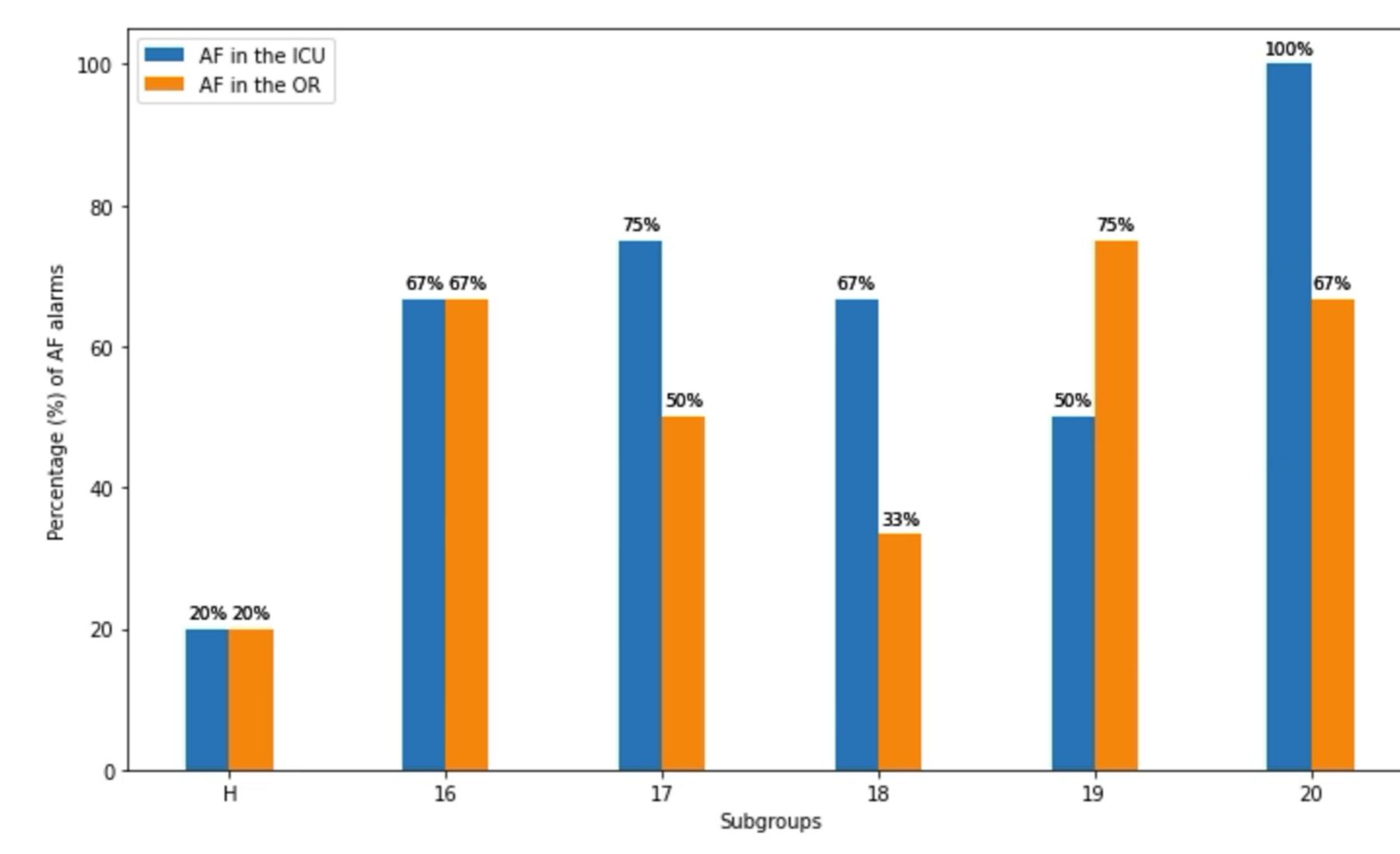
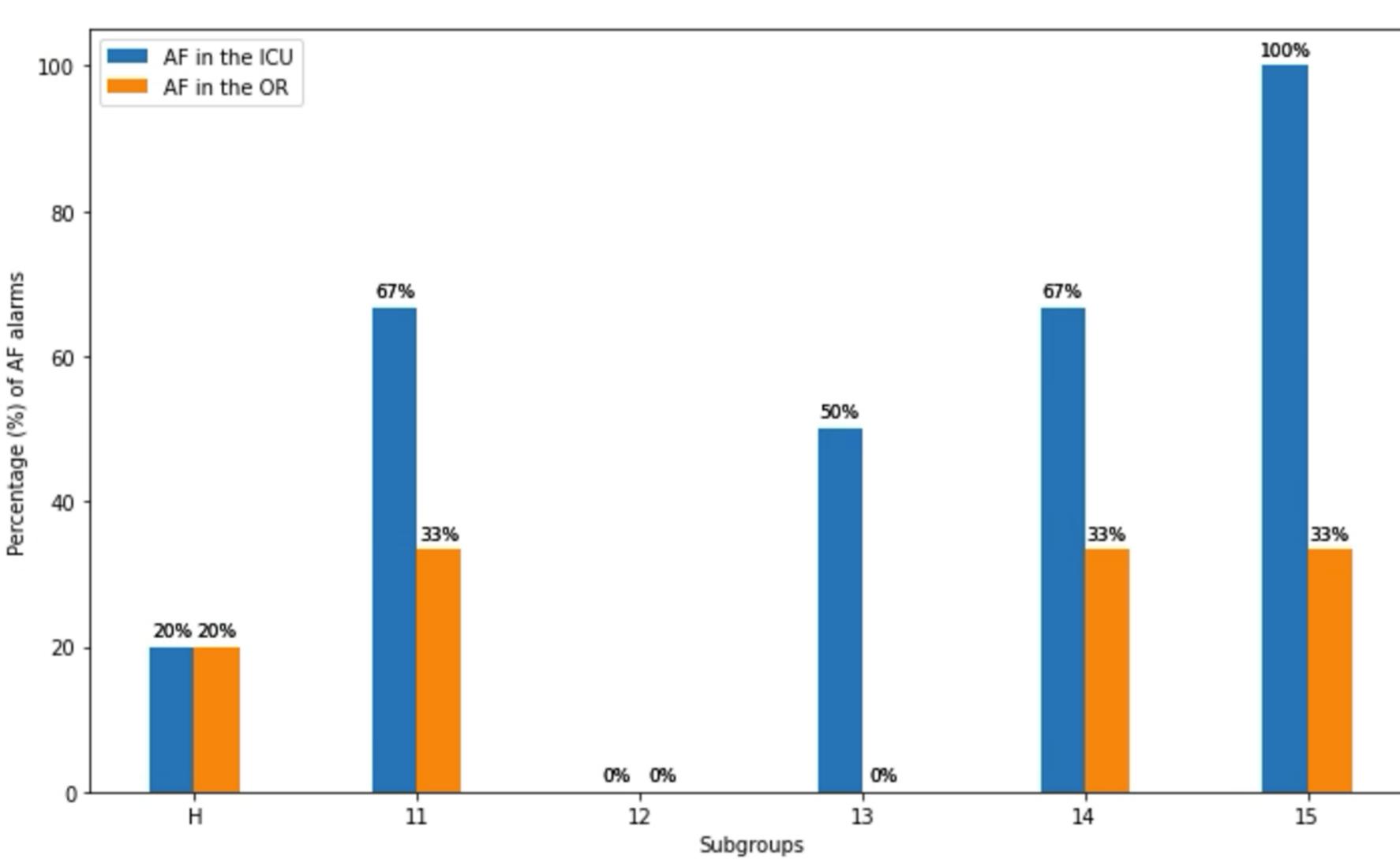
### P-wave-based: P-absence

#	n	Description
16	3	Methemoglobin = (0.9; 1.9) (normal), and Hemoglobin = (6.6; 7.2) ( <b>low</b> )
17	4	Methemoglobin = (1.5; 1.9) (normal), and Alfentanil = (24.2; 55.3)
18	3	Carboxyhemoglobin = (0.7; 1.2) (normal/high), and Euroscore = (2.5; 10.5)
19	4	Methemoglobin = (0.9; 1.9) (normal), Alfentanil = (24.2; 55.3), and CTC0000162 = False
20	3	Alfentanil = (25.1; 32.5)

### Combination: SDSD and P-absence

#	n	Description
36	3	Methemoglobin = (1.7; 1.9) (normal), and Cefazolin = (99.5; 200.4)
37	3	Leucocytes = (7.3; 14.8) (normal/high), and eGFR (CKD-EPI) = (0.0; 61.0) ( <b>low</b> )
38	3	Methemoglobin = (0.9; 1.9) (normal), and CRP = (0.0) (normal)
39	3	Methemoglobin = (0.9; 1.9) (normal), and Hemoglobin = (6.6; 7.2) ( <b>low</b> )
40	3	Methemoglobin = (0.9; 1.9) (normal), and eGFR (CKD-EPI) = (0.0; 69.0) ( <b>low/normal</b> )

**Bold** characteristics are known risk-factors for atrial fibrillation



## Results

- All HRV-based quality measures found exceptional behavior in its subgroups
- There remain redundant descriptions
- Best measure: **SDSD**
- Interesting according to experts:
  - Macrogol usage
  - Low fibrinogen levels

## Results

- Only the P-based method worked well
- F-wave-based method overfit to outliers
- Interesting according to experts:
  - Alfentanil admissions

## Results

- Combinations were able to better capture patients with AF than HRV- or P-based
- Many patients in the subgroup got AF
- Many previously known risk factors found
- Best measure: **SDSD with P-absence**
- Interesting according to experts:
  - Cefazolin admission